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Magnetic field effects on carriers capture to quantum dots

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An effect of carrier redistribution between different size quantum dots (QD) in a self-ordered InAs/GaAs QD structures has been studied by magneto-luminescence (PL) at helium temperatures.

The InAs/GaAs QDs were grown by Stranski–Krastanow method on (100) GaAs substrates. A small misorientation angle of substrate by 1–4 degree to [010] was used in order to increase the QDs density with high homogeneity and to reduce a QDs coalescence which leads to the exciton nonradiative recombination [1, 2].

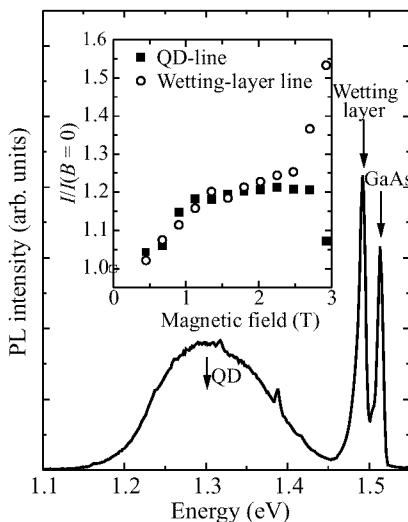


Fig 1. PL Spectrum from the sample with misorientation angle of substrate 4 degree at zero magnetic field. The temperature is 1.6 K. Inset: Integral intensity of QD-line (solid square) and wetting-layer line (open circle) in the magnetic field normalized on integral intensity at zero magnetic field.

The studied PL spectra (excited by HeNe laser) consists of three lines (Fig. 1). The high energy line at 1.513 eV coincides with an exciton recombination in the bulk GaAs barriers. The line at 1.494 eV (wetting-layer line) is due to an exciton recombination in InAs wetting layer. And the broad emission line at 1.3 eV (QD-line) is attributed to an exciton recombination in QDs. We studied a magnetic field effects on the PL spectra in Faraday configuration.

A remarkable modification of the integral intensity for wetting-layer and for QD-lines have been observed in magnetic fields (see inset for Fig. 1). The intensity of the QD-line increases with the magnetic field increase up to 1 T, then goes to saturate and decreases.

The intensity of the wetting-layer line increases with the magnetic field in all range of the magnetic field variations. Such dependence of the PL intensity can be attributed to a magnetic field effects on photocarriers capture to QDs [3]. A weak magnetic field (less than 1 T) suppresses the carrier transport to nonradiative centres only. It leads to an increase of the PL integral intensity. A strong magnetic field leads to the carrier localisation and suppresses the PL intensity from QDs with consequent increase of wetting-layer luminescence. An existence of “plateau” in these dependencies (in the magnetic fields from 1 T to 2.5 T) proves the high homogeneity of QDs.

These magnetic field dependencies of QWs PL intensity allow us to estimate the QD density which was found to be of 10^8 to 10^{10} per square cm for different samples and the density of nonradiative centres.

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